



INTERNATIONAL ATOMIC ENERGY AGENCY  
UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION



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SCHOOL ON PHYSICS IN INDUSTRY

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PHYSICS IN INDUSTRIALIZED NATIONS

presented by

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# Physics in industrialized Nations

Technological innovation:  
from scientific research to industry"

1 What Industry expects from Physics

1 What is Innovation

The Innovation process

A case history in Italy

Conclusions

These are preliminary lecture notes, intended for internal distribution to participants only.

## What Industry expects from Physics?

- 1) Ideas for new products based on recent research
- 2) New methods and technologies for improving quality or reducing costs of existing products
- 3) A sound scientific approach to be used through the Company Divisions to find out what can be improved in terms of materials, diagnostics, procedures, even marketing

## Summing up

INDUSTRY EXPECTS FROM PHYSICS  
a substantial contribution of ideas  
and a powerful technical push toward

## INNOVATION

## What does it mean "An advanced country"

- 1) In modern like in old times a country is "advanced" if it is able to cope with the present evolution of human history, with a reasonable equilibrium among the various components of civilization
- 2) That means that it must possess at high level the maximum or at least a large amount of human knowledge up to dated and must be able to face successfully new problems adopting solutions which take advantage of the most "advanced" wealth of skills and ideas which have been cumulated by mankind.

## IT IS A MATTER OF CULTURE and ORGANIZATION

- 3) A country must maintain therefore a strict connection with all the relevant aspects of culture and properly develop the related initiatives

Diffusion of Culture → TEACHING  
Development of Culture → RESEARCH  
UTILIZATION of Culture → INNOVATION

# A world changing very fast

- 1) No position of any country in an ideal international standing can be considered permanent: in culture, industry, social organization in economy situations are rapidly changing
- 2) Things are also becoming more and more inter-connected and interdependent
- 3) In any nation a particular aspect of life is more and more affected by the state of other aspects of life both inside and outside that nation

FOR INSTANCE THE STATE OF INDUSTRY might strongly depend on the efficiency of general services: Transport system, Telecommunication system, education system, even tax system, beside the obvious dependence on the state of general economy to which at the same time does contribute

# What is Innovation

Among the variously sophisticated definitions let's adopt a simple one

**Innovation is the proper utilization of a new result or a new idea to introduce new products and processes or to improve the existing ones**

- 1) It usually but not necessarily originates from scientific research. A great deal of innovation, for instance, is originated by careful evaluation of market analysis
- 2) Innovation deals with all branches of production of goods and services
- 3) Innovation is important for all kind of enterprises both private and public and should be most important with Governments which however only seldom make proper use of it.

## The innovation capability as an indicator of a country health

- 1) Nowadays capability to innovate is more important in many respects than possession of raw materials
- 2) A proper cultural, economic and social background can allow a country to pursue good innovation and to be by far better off than countries which merely possess raw materials
- 3) Examples of such a situation: Western European countries and emerging countries.  
The economies based on the added value.

## The Attitude of Physicists in the contemporary Society

Physicists usually are well aware of what happens in the world around them. However their attitude is in a way too conservative.

For instance they pay

- a) Great attention to teaching problems
- b) Fair attention to research organization
- c) Little and often no attention to innovative process

This attitude is wrong because leaves very important issues in the hands of people who do not have the proper background for handling them correctly.

It is in a way one of the several aspects of the necessity of an increasing presence of scientific culture in the modern society

## Advantages of a diversified Research System

In a country research organization can be articulated in different subjects

- 1) Universities
  - 2) Research Institutions : i.e. Academies of Science, Res. Councils, Res. Foundation (multidisciplinary)
  - 3) Research Agencies : i.e. Space, Energy (particular purpose)
  - 4) Industrial Laboratories : some of them very famous
- The presence of different kind of producers of Research, allows usually a more efficient activity tailored on the particular characteristics of a research problem.

In principle all the above mentioned Institutions can carry out research providing a scientific basis for Innovation

## Naivete of Physicists in their approach to innovation

- 1) They believe that a result based on more recent and brilliant theories is more valuable for innovation than other ones based on fully consolidated parts of physics
- 2) They often forget the severe constraints coming from the various components of industrial reality (the market or the list of orders). Among them we must not underestimate the role of the scientists working in that industry who are usually not enthusiastic about things Not Invented Here
- 3) They believe that their results are widely known for the very simple reason that they have been published or because even a "patent" has been issued
- 4) They expect a few industrialists to call up respectfully to ask kind permission to make use of those magnificent results.

## How scientific results can find their way to Industry

- 1) Outstanding results of industrial interest  
NO PROBLEM
- 2) Relevant results: Sometimes big problem. It depends from where they have been obtained. Often prejudices might build a barrier.
- 3) Inrelevant results: They find their way to Industry more often than they deserve because are strongly pushed by authors which have found little if any gratification from the scientific community.

A scientific result is a potentiality which must be properly cultivated to become a real asset.

It is like in other fields of life for natural talents, like in art or sport.

We must consider that to day Society needs not only the fabulous peaks but also and perhaps even more to keep a good general average

## A scientific result must be properly handled to find its way to Industry

- 1) It is rather easy for Industrial laboratories but sometimes problems arise among different Division.
- 2) More difficult for Research Institutions and Universities. It can become easier if a proper organization for submitting results to industry exists. It does happen in several developed countries.
- 3) Extremely difficult in emerging countries.

## The innovation process

According to careful analysis it can be divided in several steps

(See for A. Piater: *Obstacles to Innovation*.  
(A EEC Study based on "ad hoc" reports  
from EEC Countries) Bruxelles 1981)

- a) Innovative idea
  - b) Research
  - c) development
  - d) making of a prototype or of a pilot plant
  - e) Engineering
  - f) certification
  - g) marketing
- Production of innovation
- Transfer of innovation
- Utilization of innovation in product lines

## A case history in ITACY

- a) Why to do something for innovation
- b) What can be done in Universities and in public Institutions
- c) The case of the Institute of Solid State Physics
- d) The Finalized Project "Materials and devices for Solid State electronics"

# The Institute for solid State Electronics

- 1) Research Lines      Semiconductor Devices  
                                  Superconductor Devices  
                                  Magnetic Devices

About 30% of the resources is devoted to fundamental research: Gravitational waves, magneto-optics, noise, Mössbauer experiments, synchrotron radiation

- 2) Size: small      20 scientists + 20 others

- 3) Relevant technologies: E.B.L.  
                                  S.Q.U.I.D.  
                                  Growth and diagnostics of GaAs films  
plus standard semiconductor, superconductor and magnetic research techniques

- 4) Industrial cooperation: ENICHEM for sensors  
                                  SELENIA for microwave devices  
                                  Electronics for Biomagnetics

Joint project with SGS-Thomson - CNRS - King's College for X-Ray Lithography within ESPRIT PROJECT

# The Finalized Project

Purpose: To bring together research efforts of Universities, Public Institutions and Industries, towards a goal of social or industrial relevance

Finance: Financial support comes directly from the Government Budget by means of "ad hoc appropriation"

Operation: CNR (National Research Council of ITALY)

Duration: Five Years

Examples: Social relevance: Biomedical Technologies

Increase of Food resources

Industrial relevance: Mechanical Technologies

Solid State Electronics

| SOTTOPROGETTI                                                           | TEMI                           | PERSONALE<br>(UOMINI/ANNO) | SPESA<br>(MLIT) |
|-------------------------------------------------------------------------|--------------------------------|----------------------------|-----------------|
| MICROSTRUTTURE<br>VLSI                                                  | PROCESSI TECNOLOGICI           | 150                        | 21.000          |
|                                                                         | FISICA E MODELLI               | 75                         | 3.500           |
|                                                                         | ARCHITETTURE E CAD             | 285                        | 22.000          |
| MATERIALI E<br>DISPOSITIVI<br>PER MICRO-<br>ONDE E OPTO-<br>ELETTRONICA | STRUTTURE ALTA MOBILITÀ        | 40                         | 4.040           |
|                                                                         | CIRCUITI MONOLITICI            | 25                         | 1.630           |
|                                                                         | MATERIALI DISP. MAGNETICI      | 30                         | 1.780           |
|                                                                         | MATERIALI DISP. COMUN. OTTICHE | 70                         | 7.200           |
|                                                                         | ELAB. OTTICA DEL SEGNALE       | 90                         | 5.100           |
|                                                                         | OTTICA GUIDATA                 | 40                         | 2.500           |
| SENSORI                                                                 | SENSORI INTELLIGENTI           | 106                        | 7.300           |
|                                                                         | SENS. A FILM SPESSO E SOTTILE  | 86                         | 6.070           |
|                                                                         | SENSORI DI SPOSTAMENTO         | 20                         | 170             |
| DISPOSITIVI<br>DI POTENZA<br>A SEMICONDU-<br>TORE                       | DISPOSITIVI ALTA POTENZA       | 35                         | 2.100           |
|                                                                         | MODULI A TRANS. POTENZA        | 55                         | 4.000           |
|                                                                         | GTO A MEDIA E BASSA CORRENTE   | 45                         | 3.700           |
|                                                                         | ALTRE APPLICAZIONI             | 25                         | 1.500           |
| AFFIDABILITA'<br>E<br>DIAGNOSTICA                                       | DIAGNOSTICA                    | 70                         | 9.400           |
|                                                                         | CARATTERIZZAZIONE FUNZIONALE   | 55                         | 6.700           |
|                                                                         | TECNICHE DI SOLLECITAZIONE     | 25                         | 2.950           |
|                                                                         | FISICA MECCANISMI GUASTO       | 45                         | 4.000           |
|                                                                         | MODELLI MATEMATICI             | 25                         | 2.150           |

## CONCLUSIONS

- 1) A lecture on innovation "The oil crisis of 1974"
- 2) Innovation pervades everything everywhere. It is either produced or forced upon
- 3) Are the physicists keen to take part to innovation process? Not too much, particularly from emerging countries
- 4) My own experience in meetings and as an editor of a scientific Journal
- 5) The reasons, at least some possible reasons:
  - a) aggratification of fundamental research which is the ideal ground to compete & with colleagues from developed countries
  - b) frustration of applied research for the opposite reason
- 6) However a push toward innovation might be for e emerging countries more profitable than a big loan or some political assistance
- 7) Physicist of emerging countries must do their best to reduce distance between the world of business and the world of culture. A correct innovation policy can help a great deal
- 8) In my opinion mankind needs now more a proper utilization of existing knowledge than a reckless expansion of it.
 

To work toward this goal is the best action physicists can take toward the building of a more, just world

1. The first part of the document is a list of names and dates, which appears to be a record of some kind. The names are written in a cursive script, and the dates are in a more formal, printed style. The list is organized into two columns, with names on the left and dates on the right.

2. The second part of the document is a series of short, handwritten notes or entries. These are written in a cursive script and are organized into a list format. The notes appear to be related to the names and dates in the first part of the document.

3. The third part of the document is a single line of text, which appears to be a signature or a date. It is written in a cursive script and is located at the bottom of the page.